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STRUCTURAL LINEAMENTS AND MINERALIZATION IN SOUTHEAST MISSOURI

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INTRODUCTION

In an earlier report (Kisvarsanyi and Kisvarsanyi, 1976) we have defined several major structural lineaments in southeast Missouri by using satellite remote-sensing imagery (LANDSAT-1 and LANDSAT-2) of the area. In addition to the major linear and curvilinear features confirmed or discovered in the course of that preliminary analysis of multispectral imagery, a large number of circular and arcuate features were also identified.

This paper is a brief summary of the results of our investigations, with special emphasis on the influence of the structural lineaments on the distribution and local concentration of metallic minerals.

STATEWIDE PATTERN OF LINEAMENTS

LANDSAT-1 and LANDSAT-2 imagery indicate a distinct pattern of linear features throughout the state (fig. 1). The greatest frequency of lineaments occurs south of the 38th parallel north latitude, with the highest density occurring in southeast Missouri. Several major NW-trending lineaments are 200 to 300 mi

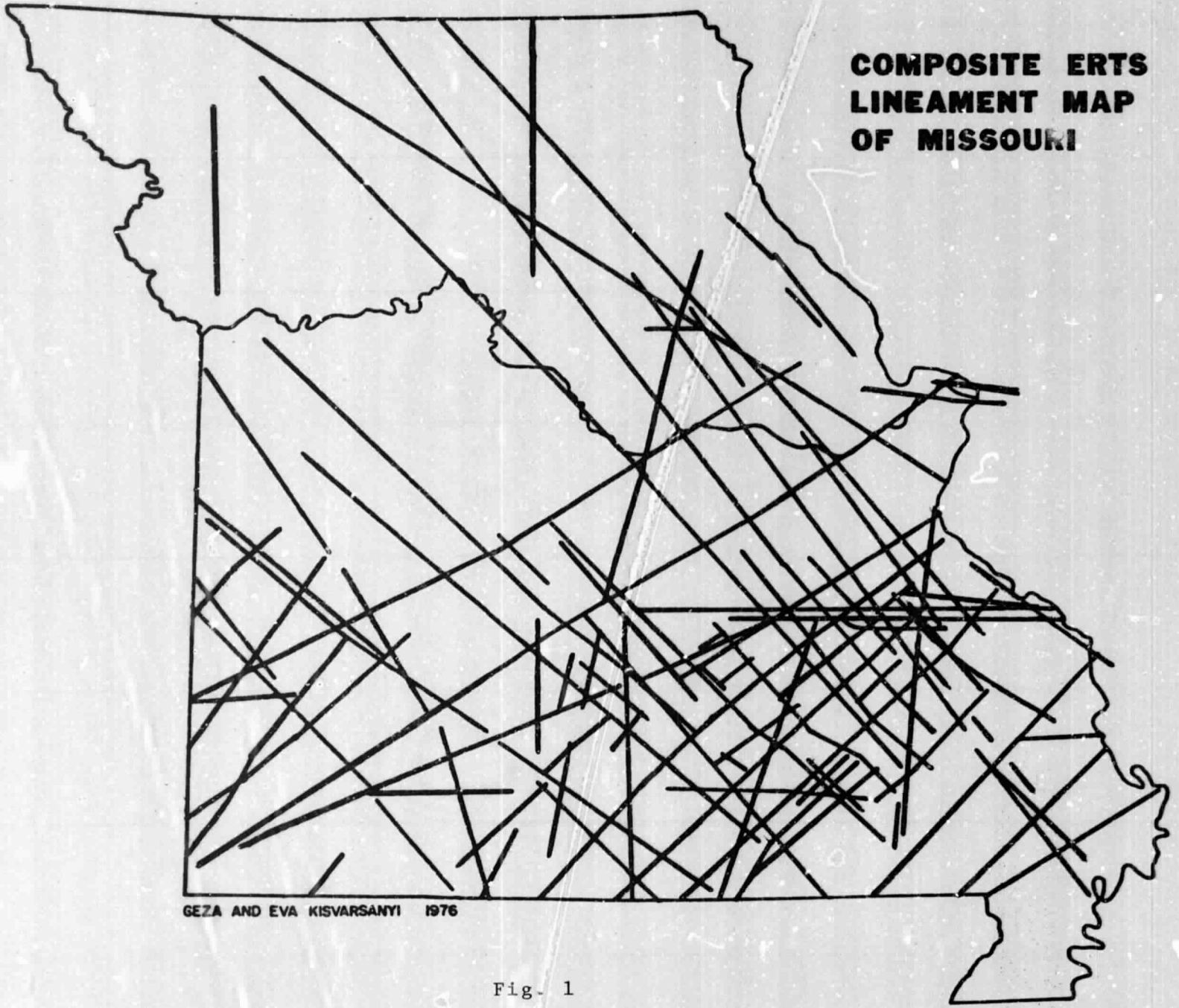

Fig. 1

long and extend into northern Missouri. The most prominent of these is expressed on the ground as a geomorphic feature, namely, the valley of the Grand River in northwest Missouri, and continues on strike with a segment of the Missouri River in central Missouri. NE-trending lineaments are generally restricted to the southern half of the state; many of these extend into northern Arkansas.

Comparison of the lineament map (fig. 1) with the Structural Features Map of Missouri (McCracken, 1971) indicates that known and mapped structures (faults, snyclines, anticlines) correlate very closely with the lineaments. Intersections of lineaments in several places coincide with structurally disturbed areas and cryptoexplosion structures. Geomorphic features, such as river courses and topographic escarpments, in hundreds of places across the state appear to be lineaments and may be expressions of fractures, faults or other geologic features.

A good correlation exists between lineaments and major magnetic anomalies (Magnetic Map of Missouri, 1943). In many places, deep drilling indicates that the magnetic anomalies are caused by mafic intrusive bodies in the Precambrian basement (E. B. Kisvarsanyi, 1974). Coincidence of a string of magnetic anomalies in northern Missouri with the Grand River lineament, and coincidence of another series of magnetic anomalies west of St. Louis with a major NE-trending regional lineament strongly suggest deep-seated structural control. The distribution of Precambrian iron-ore deposits in southeast Missouri is also expressed by magnetic anomalies and shows correlation with lineaments identified from the image y.

Aeromagnetic maps, where available, frequently display excellent magnetic lineaments. In central Missouri, a prominent aeromagnetic lineament corresponds closely with one of the major NW-trending lineaments, identified from the imagery which passes through the Decaturville structure. Recent mapping indicates that several faults in this area are along strike with this lineament (Ira Satterfield, pers. commun., 1976).

The greatest density of lineaments is observed in the area of exposed and shallow Precambrian basement in southeast Missouri. Both in southwest and central Missouri the relatively dense lineament pattern occurs over buried Precambrian highs as indicated on the contour map of the buried Precambrian surface (E. B. Kisvarsanyi, 1975). Lineament density in Missouri therefore appears to be inversely proportional to the depth of the Precambrian surface. The Precambrian basement, as a tectonic unit, must have exerted a profound influence over igneous activity, mineralization, and structural movements throughout the history of the region.

RELATIONSHIP OF LINEAMENTS, CIRCULAR FEATURES, AND MINERALIZATION IN SOUTHEAST MISSOURI

Comparison of the lineament map with the distribution of major mineral deposits in Missouri (E. B. Kisvarsanyi, 1965) shows a close geographical association. Mineralized areas in the southern part of the state are found on or along lineaments or near the intersection thereof. The frequency and distribution of lineaments is most regular and repetitive in the area of the Southeast Missouri Mining District (fig. 2). A definite

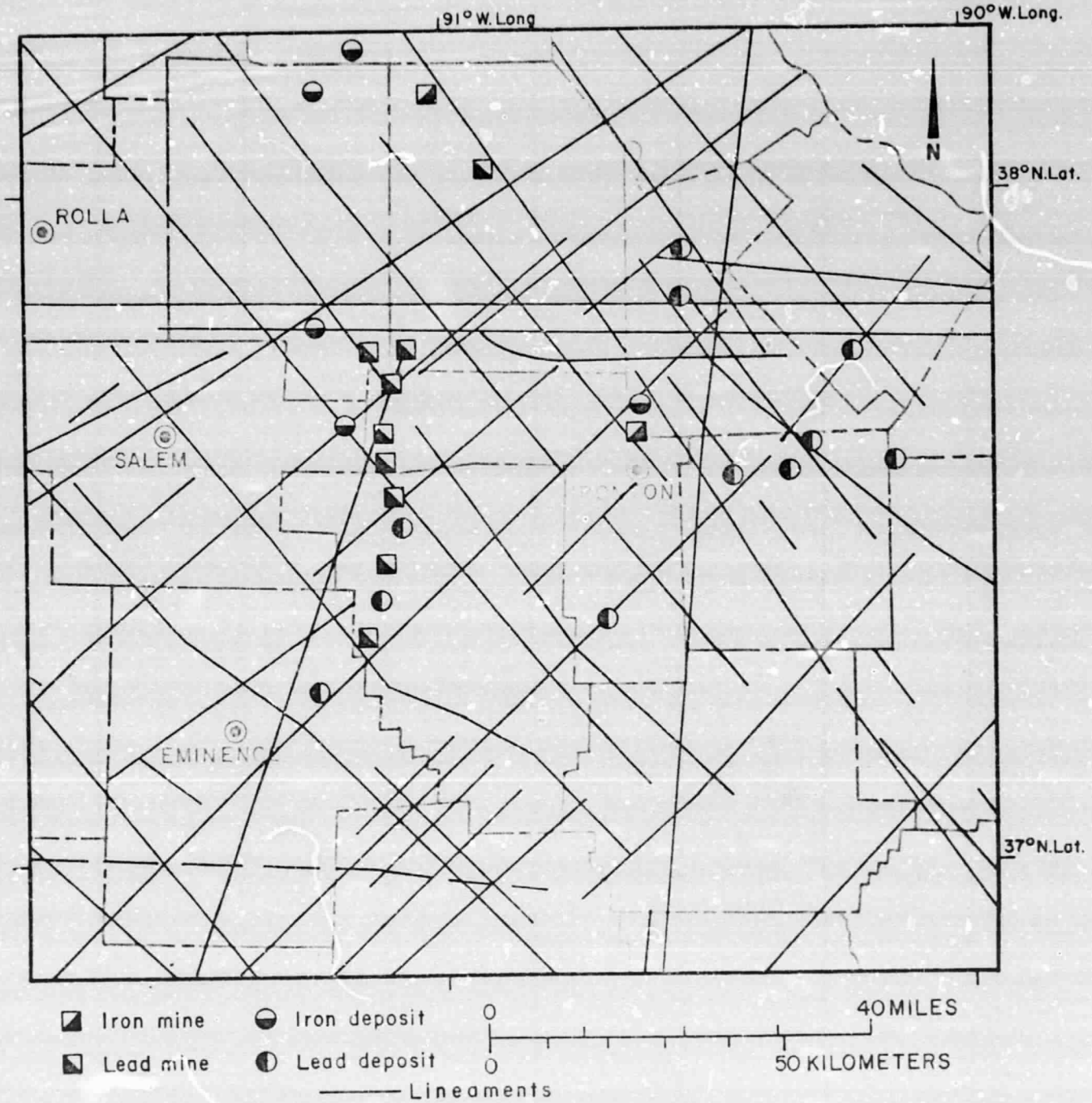

Fig. 2

lineament pattern is also associated with the formerly productive southwest Missouri part of the Tri-State Mining District and with the Central Missouri District. Along the Arkansas-Missouri border, several smaller mineral deposits have been located near the intersections of lineaments in intensely brecciated rocks.

The spatial association of lineaments, as identified from the multispectral imagery, with the major iron and lead-zinc-copper deposits of the Southeast Missouri Mining District is illustrated in Figure 2. The Precambrian outcrop area of the St. Francois Mountains is centered around the town of Ironton (fig. 2). The lead-zinc-copper deposits of the Viburnum Trend Mining District are located along an approximate N-S line, about 25 mi east of Salem.

Several of the lineaments shown in Figure 2 correspond to faults or fault systems mapped in the Precambrian rocks and in the overlying sediments. The lineaments frequently extend on strike beyond the mapped length of faults. Many of the lineaments, however, are not associated with mapped faults. They may alternately be coincident with drainage patterns, topographic escarpments, igneous-sedimentary contacts, mineralization, the intrusions of diabase dikes, and zones of brecciation along their strikes. They are believed to be expressions of deep-seated fracture-fault systems in the Precambrian basement, and their width on the ground surface may be measured in hundreds or in thousands of feet.

Circular and arcuate features are particularly abundant in the area of exposed and shallow basement in southeast Missouri

(fig. 3). They tend to be clustered in areas underlain by volcanic rocks. Where these rocks are exposed, as in the area of the Taum Sauk Caldera west of Ironton, and east of Eminence, the circular pattern is also visible on 1:24,000 scale topographic maps and on stereo images of airphotos. Circular features over buried basement are in part defined by curving segments of stream channels; others appear to encircle isolated small outcrops of volcanic rock around sediment-filled depressions. Some known cryptoexplosion structures also appear on the LANDSAT imagery as circular features. Several circular and arcuate features have been observed along the Viburnum Trend (fig. 3).

The circular features may be volcano-tectonic in nature, subsided cauldrons, or circular plugs, and appear to be related mostly to a mechanism of Precambrian magmatic activity. Some ignimbrite sheets may have issued from circular fractures and intrusive bodies may also exhibit cylinder-like circular patterns. Some circular features appear to be cut by others, or by faults, representing some age difference. It is possible that some circular features are of different origin and are genetically related to mineralization. Detailed ground-truth investigations are needed to determine the importance of these features in the evolution of the St. Francois terrane, and to determine their role, if any, on mineralization.

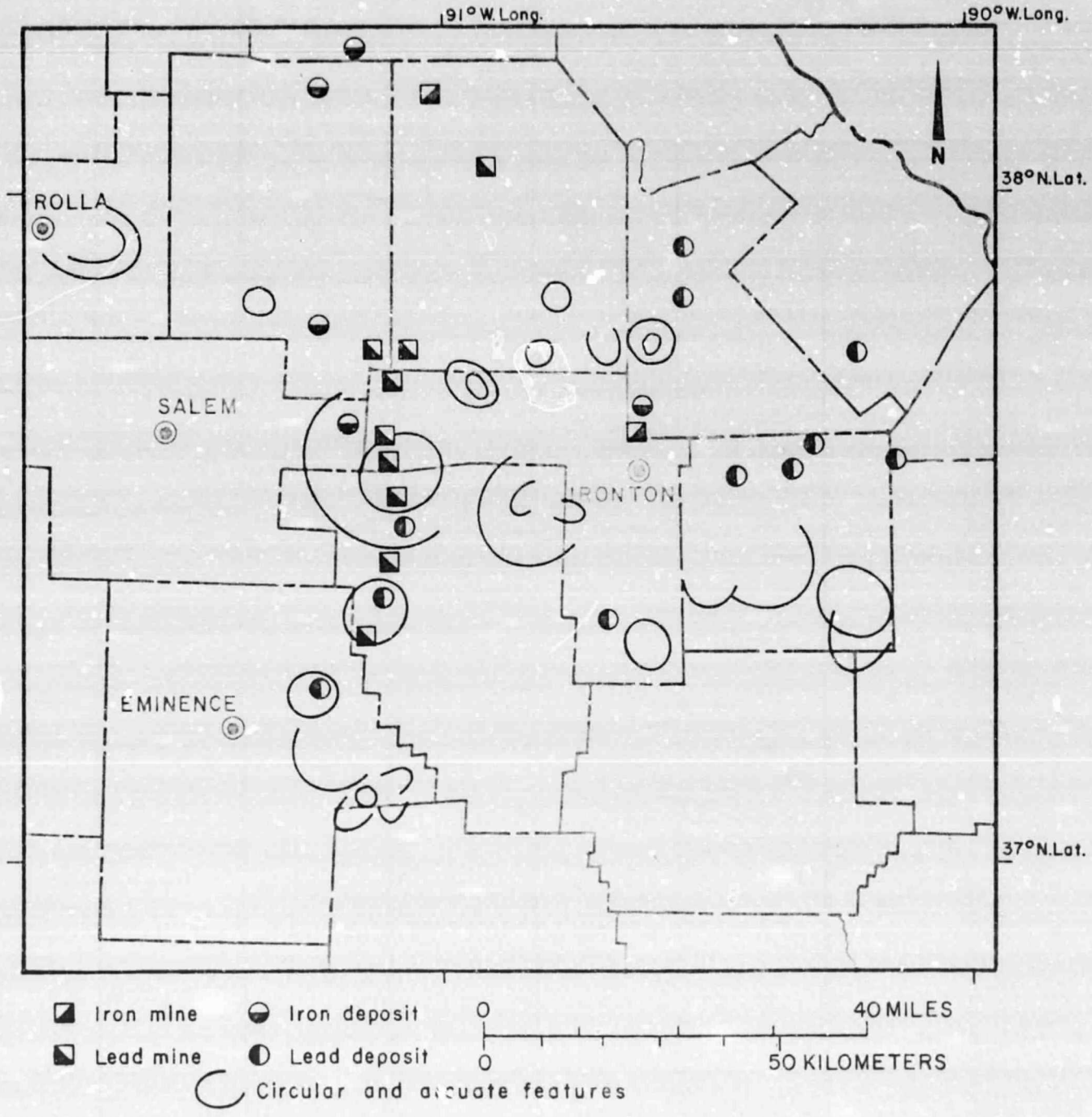

Fig. 3

TECTONIC FEATURES OF THE METALLOGENIC PROVINCES OF SOUTHEAST MISSOURI

An important phase of structural analysis is the recognition of metallotects, particularly, the tectonic controls of ore deposits in metallogenic provinces. Southeast Missouri is the site of two major metallogenic provinces of North America. One of these is the Precambrian iron-copper-manganese province and the other is the Mississippi Valley-type lead-zinc-copper province in the Paleozoic sediments. The Washington County barite district, residual deposits of iron, veins of tin, tungsten, silver and lead are also within the area.

The ore deposits of the Precambrian igneous province are localized along fractures and faults, and the stratabound lead-zinc-copper deposits are concentrated at the frequently faulted hinge zones of Precambrian structural highs and lows. The influence of the Precambrian basement on the stratabound mineralization has been discussed by G. Kisvarsanyi (in press). Faults and fractures brecciated sedimentary rocks and controlled the movement of mineralizing solution. The residual barite deposits are localized along fracture zones in the carbonate host rocks. A distinct relationship is recognized between the distribution of kimberlite-alnöite dikes and diatremes and the structural lineaments of the Avon area. Such a system of interrelationship between major structural lineaments and alkalic ultramafic complexes has been demonstrated in Angola and other parts of Africa (Reis, 1972).

In order to bring the interraltionship of tectonic elements and mineralization into sharper focus, minor concentrations of metals (prospects and "shows") in both the Precambrian and the Paleozoic rocks have been plotted on the structural-lineament map of southeast Missouri along with the important mineral deposits. The distribution of mineralization shows a degree of coincidence with the structural lineaments of the region, which in turn appear to be a function of its Precambrian structure. The fracturing and faulting of the Precambrian basement have created an intricate plumbing system which provided avenues of access for metal-bearing solutions in Precambrian and later time. Such a system might permit ascending solutions to reach favorably prepared (fractured, brecciated, etc.) host rocks, lateral migration and redistribution of metals, and control of descending ore fluids along fractures produced by Precambrian and Paleozoic epeirogeny.

Local and regional structural elements had an important role in the formation and localization of the ore deposits of the region. Careful analysis of the individual lineaments and their pattern in the region should be a useful exploration tool.

Further investigations are needed to establish the interrelation of ore deposits with the lineaments observed on the satellite imagery. Geographic association alone may not be meaningful if the genetic relationship of lineaments and ore emplacement is absent. Furthermore, the emplacement of ore deposits may be controlled by smaller structural elements which are not visible on satellite imagery. The association of lineaments and ore deposits may be closer, or better displayed in the

Precambrian ore deposits than in the stratabound deposits. In the latter, other than structural factors, such as the Lamotte pinchout, permeability of sediments, chemical environment, etc., had also influenced ore deposition.

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